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GENETICS AND EMBRYOLOGY[1]

By Professor CHARLES ZELENY

UNIVERSITY OF ILLINOIS

THE rapid rise of genetics has led to difficulties in relating its findings to those of embryology. The view has been expressed that progress in genetics is endangered by explorations in border fields. The problem has a general significance and seems to warrant discussion before a group of zoologists.

INBREEDING AND OUTBREEDING

In treating these difficulties it may be allowable to take a theory of one of the necessary conditions of evolution and to apply it to the analogous realm of scientific progress. Among the numerous constructive contributions of genetics to the discussion of the factors of evolution is the support it gives to the view that periods of isolation alternating with periods of intermingling among groups are necessary for progress. Inbreeding and outbreeding are both essential. New hereditary constitutions are swamped by outbreeding, and their recessive genes are incapable of expression under the condition of free contact within a large population.

With progressive isolation, small, homozygous, closely knit populations are produced. Each establishes its own clear and definite racial qualities. Many of the groups die out because of inherent weakness. Others have innate vigor and continue to flourish under isolation for a considerable period of time.

For the latter, two roads are open. If they continue in isolation their homozygous constitution leads to stagnation and their incapacity for rapid response to changing environments dooms them to extinction. If, on the other hand, after they have established themselves under isolation and are no longer in

[1] Address of the vice-president and chairman of Section F—Zoological Sciences, American Association for the Advancement of Science, presented at the Zoologists' dinner, Atlantic City, December 29, 1932.

danger of being swamped by outbreeding, they break through the barrier separating them from their neighbors, they give and receive valuable contributions. A great variety of new gene combinations becomes available. A new period of isolation may establish some of these as promising steps in further evolution. So, with alternating cycles of inbreeding and outbreeding, rapid evolution is made possible.

This theory may be extended to the analogous conditions of scientific progress. The enthusiasm of a group in a special field may lead to isolation. Isolation favors the development of clearly defined concepts and of well-organized programs of investigation along the lines prescribed by these concepts. This favorable result, however, may be followed by the development of routines of procedure, leading, if the isolation be long continued, to eventual stagnation and sterility of the field in question.

From this sad fate the special science may be rescued by the stimulus of excursions into neighboring realms. The explorers may bring back many "wild and unusual" data that refuse to be confined within the corrals of the defenders of the home territory. Much confusion results. The situation is "viewed with alarm" by the home guard. But from these outside contacts new concepts arise which gain precision and clear definition in a new era of organized investigation. Thus alternating periods of isolation and of contact favor scientific progress.

History of Genetics

Among the difficulties connected with the establishment of genetics were (1) the preoccupation of biologists with the interests and enthusiasms aroused by the publication of Darwin's "Origin of Species," (2) the introduction of a method of investigation unfamiliar to biologists, and (3) the inadequacy of knowledge of the processes of sexual reproduction.

Upon the rediscovery of Mendel's laws a small, compact body of active investigators extended his method to an ever-increasing number of species and to all details of somatic characteristics, including form, size, function and even behavior. The concept of stable units of heredity, or genes, was firmly established as a general law, and coordinately with it the law of segregation of the units of a pair in the formation of the gametes and the independent assortment of different pairs. Independent assortment was found to have exceptions. Linkage groups were recognized, and within a group there was discovered a certain percentage of breaking of the linkage, constant for any two pairs of genes. These percentages were shown to have a definite quantitative relation, such that the values in any linkage group could be arranged in linear order. And so, on and on, analyses of heredity data were made in terms of symbols, the genes, in a manner analogous to the atomic system of the chemists.

The investigators in genetics formed a compact body, the members of which had the same desire for demonstration of the universality of application of the gene concept. A very close inbreeding of ideas occurred, making the concept more and more well defined, unquestioned and all-sufficient. This isolation was of great importance from the standpoint of adequate development and demonstration of the gene concept. If the majority of geneticists had devoted their time from the very start to seeking points of contact with prevailing views in other biological fields, instead of devoting themselves to their knitting, the progress of the science of heredity might have been swallowed up in a morass of conflicting and imperfectly grounded speculations.

The next stage was not so profitable. Viewing with satisfaction the tremendous advance in "atomic explanation" of heredity and the ever-increasing number of individual cases to which it could be applied, geneticists tended to continue in isolation indefinitely on the ground of lack of sufficient data for an adequate approach to other biological fields. The fact that at its beginning the view of general significance of Mendel's results was a wild speculation, seemingly contrary to the bulk of previous observation, was forgotten. The need of stimulation by foreign ideas was lost sight of in the desire for retaining clearness of objective. In other words, the inbreeding was giving rise to a homozygous population of ideas, and genetics seemed destined to the stagnation and sterility of an exercise in gene sorting.

The Cytological Frontier

From this stagnaton genetics was rescued temporarily by the older and continuing developments in cytology. The contacts here illustrate both extremes of functional relationship.

In the one extreme, two separate fields of biological inquiry develop independently to such an extent that the observations in one fit naturally into a common system with the other. No test is necessary. No independent demonstration is needed. For example, the law of segregation of genes fits naturally into the cytological observation of the separation of the chromosomes of a pair during maturation.

In an intermediate situation, observations in one field seem so obviously to be explained by those in another, yet without direct confirmation, that after the relation between the two is suggested, the confirmatory test may be applied at once. Test follows suggestion inevitably. For example, the law of independent assortment of different pairs of genes sug-

gests independent assortment of different pairs of chromosomes. But such assortment of chromosomes could not be demonstrated until marked pairs were available for cytological observation. (Explanation of linkage of genes as due to location within a single chromosome also followed as a natural consequence of this hypothesis.)

At the other extreme, daring hypotheses of relationship are necessary. They must be *working* hypotheses, recognized as capable of test and therefore stimulating the invention of devices for test. A good example is the daring speculation on the cytological basis of linkage breaks, the view that the percentage of breaks in linkage is explained by the percentage of crossing over between the members of a pair of chromosomes. Its natural sequel is the view of a linear order of gene-containing chromatin granules within a chromosome and the accompanying exercises in chromosome map construction. When first formulated this hypothesis certainly was a daring speculation, but being accepted as a working hypothesis it was capable of test and has been substantiated in many different ways. The stimulus it gave to constructive work in genetics does not need review before this audience.

The success of the first excursions into the cytological realm led to similar ones concerned with deficiencies, translocations and many other phenomena of genetics. Continued success led to practical obliteration of the frontier, and now the terminology of the older genetics is fused with that of cytology, and the old symbols for units of heredity have become parts of chromosomes. Genetics, having incorporated cytology into its realm in this manner, entered upon a new program of sorting and rearranging genes and groups of genes. In place of the algebraic symbols of the old genetics, there were substituted the chromatin granules and chromosomal rods of the new, and these can be sorted and rearranged even more readily than the old symbols. The enthusiastic endeavors and striking advances in this field are commonplaces of recent genetics.

The cross between genetics and cytology was fertile, and the new period of inbreeding in the united realm has standardized concepts and procedures. The concepts are morphological ones and have now reached sufficient maturity so that they may be safely outcrossed with physiological and embryological ones.

The Embryological Frontier

The wide gap between the genes as postulated units of heredity and their somatic expression in the adult can be bridged only by observations of embryological events. As at other frontiers, besides independent cultivation of the two fields in the hope that some obvious connection will appear, there should be coordination of experimental procedures, including materials from both sides.

Genetics supplies a technique for controlling hereditary constitutions. Experimental embryology supplies a technique for control of internal and external environments. From the embryological side a comparison can be made of two reaction systems, alike in all respects but one, and that one a single gene or a single component of the environment. A program of procedure based upon this possibility should throw valuable light upon the nature of genes and upon the physiological processes initiated by them. Study of time, place and nature of the changes in relative rates of physiological processes is of the greatest importance. In such a study the succession of events in the regeneration of an organ is a valuable aid and often yields clearer results than does a study of the more complex transformations of normal embryology.

Genetics made early contacts with embryology in the field of dominance, but for a long time evaded the issue by means of the presence-and-absence hypothesis. Multiple allelomorphs, the multiple effects of a single gene difference, the multiple factors concerned in a single somatic character, the effects of deficiencies and numberless other observations suggest intimate functional relations with embryology.

As examples, two embryological investigations will be outlined: the first is far from the frontier and concerns some observations on the development of serpulid worms; the second is near the frontier and concerns some observations on the bar-eye series of multiple allelomorphs in Drosophila.

Serpulid Development

In all genera of serpulids the worm secretes a calcareous tube. There are two semicircles of gills, one on each side of the head. Each gill has a central shaft with thread-like pinnules on each side and with a terminal thread. The gills have a food-collecting as well as a respiratory function.

In the adults of one group of genera, of which Protula is an example, all the gills retain this typical gill structure.

In the adults of a second group, of which Apomatus is an example, the second gill from the dorsal side in each row has a terminal enlargement in place of the terminal thread. This acts as a plug, or operculum, for closing the mouth of the tube. Both of these modified gills retain the lateral pinnules and continue to have a respiratory and food-collecting function as well as the opercular one.

In the adults of a third group of genera, of which Serpula is an example, in place of one of the second gills there is an operculum without gill function. Its

stalk is without the lateral pinnules, and the terminal enlargement is a simple cup with a notched edge. In place of the other second gill, there is a bud of embryonic cells, the rudimentary operculum.

In the adults of the fourth group of genera, of which Hydroides is an example, the relations of the structures are like those of the third group, but the functional operculum is a much larger and more complicated organ, having its terminal enlargement made up of two distinct cups, each with its own spines.

In their individual life cycles members of the fourth, or Hydroides, group pass through definite stages resembling closely the adult stages of the other groups. Emphasis is to be laid on the fact that these stages are passed through after the worms have completed the egg and free-living larval stages and after they have entered upon the sedentary mode of life in a calcareous tube. In each stage the function of the organs of the opercular series is the same as that of their adult homologues. The stages are not the transitory phases of a construction process. Furthermore, one stage is not, in any obvious sense, a necessary mechanical step in the building of the succeeding one. In fact, the transformation involves a radical destruction of parts of the preceding stage and the construction of strikingly different new parts. In some of the steps of the transformation the whole old organ is destroyed and is replaced by a new one.

The process warrants further description of the development of Hydroides. Soon after the free-swimming larvae settle down and secrete a limy tube, they form a right and a left row of gills, of the first, or Protula, type, without opercular modifications. After several days in this condition, the cells at the base of the terminal thread of the second left gill divide rapidly, forming an opercular enlargement, and the terminal thread is absorbed, but the stalk retains its lateral respiratory pinnules. The organ now has the general plan of the second gill of the second, or Apomatus, type. The opercular swelling continues its growth and forms a single cup with a serrated edge. The lateral pinnules are absorbed and the organ is a functional operculum of the adult third, or Serpula, type. In the meantime, the second right gill stops its growth, its terminal thread and lateral pinnules shrivel, and the stalk drops off at a definite cleavage plane near its base. The cells of the basal stub proliferate to form a small bud of embryonic character. At this point the whole opercular system, right and left, resembles that of adults of the genus Serpula. After a few weeks in this condition, a time during which new gills are added at the ventral edge of each branchial circlet, the functional operculum, in the position of the second left gill, drops off at a basal cleavage plane. The embryonic bud at the position of the second right gill now enlarges rapidly and develops into an operculum with a complicated double cup of the fourth, or adult Hydroides, type. At the same time, a bud of embryonic cells, the new rudimentary operculum, is developed in place of the lost functional operculum of the third, or Serpula, type.

According to the findings of genetics, the gene complement of the cells involved in the development of the second gill, right or left, remains unchanged throughout the life cycle of Hydroides. It is stimulated to respond in one way at one time and in another way at another time, or the physiological processes initiated earlier in the life cycle and involved in the opercular modification, affect the cells in these positions in different ways at different times. That the structural differentiation at any stage is not merely part of a sequence of necessary events in the erection of the adult structure is evidenced by the fact that regeneration of the removed functional organ (whether gill without opercular modification, gill with opercular modification, Serpula type of operculum or Hydroides type of operculum) gives a replica of the removed organ *without recapitulatory stages*. Thus an organ may be repeated in duplicate by appropriate stimulation either of the basal cells of the removed organ or of the prepared embryonic bud of the opposite side. Transplantation technique should yield further important results.

A stage in such a series is not the natural developmental consequence of the immediately preceding type of development of an organ. The change is a deep-seated one, involving other parts of the body and concerned with the time at which the gene complex is stimulated to activity.

The same genes stimulated by the different physiological agents of different periods of the life cycle give strikingly different somatic results at a particular point in the individual. In the same way, two exactly similar gene complexes of two groups of cells located in different parts of the same individual may at *one time* respond in different ways because the stimulating agents differ. The problem of differentiation of the individual, therefore, is one involving both time and place, though the gene complex is postulated to remain constant and independent of time and place.

From the standpoint of the recapitulation theory in its old form, the embryological facts find a ready explanation in terms of the supposed phylogeny of Hydroides. The problem may, however, be stated in other terms. How can one hereditary constitution give a juvenile organ different from its own adult organ but similar to the adult organ resulting from another hereditary constitution? The answer is not

apparent, but two considerations may have a bearing upon the question: First, the differences in the opercula of the adults of the four groups of genera are similar to differences resulting from gene mutations in other animals. Second, changes in physiological processes resulting from environmental factors have been shown in many cases to resemble changes in physiological processes resulting from gene mutation without corresponding environmental change. May we not be justified in formulating the *working* hypothesis that gene mutation produces change in gene reaction similar to that produced in physiological processes by environmental change? And further, may we not be justified in hunting here for clues to the nature of gene action and even to the nature of gene structure?

Why does a gene complex express itself at the site of the second gill in different ways at different times in the life cycle? A gill without opercular modification, a gill with opercular enlargement, an operculum of the Serpula type and an operculum of the Hydroides type—these are not stages in the development of the adult Hydroides structure; but, as regeneration studies show, they are characteristically different and independent expressions of a single genotype at one and the same location in the developing individual. Certainly a more intimate study of the developmental processes in ontogeny will throw some light on the nature of the gene differences at the basis of differences in adult somatic expression. Such a study should pay special attention to regeneration and grafting technique in forms differing in a single gene or in a single environmental factor when all other hereditary and environmental factors are controlled.

Multiple Allelomorphs

The second embryological investigation concerns the changes produced by a single gene mutation.

The different members of the bar-eye series of allelomorphs in Drosophila have characteristic differences in size of the eyes and in number of ommatidia as determined by facet counts. From the genetics side much is known of the normal rates of mutation, quantity and position effects within the gene or its immediate neighborhood, and acceleration of the rate of mutation under x-ray and radium treatment and at high temperatures.

The number of eye facets is strikingly affected by the temperature of the developing individual, and each mutant has its own temperature coefficient. In most of the members of the series the number of facets decreases with increase in temperature, but in infra-bar there is a reversal of the temperature effect. The characteristic adult somatic differences of several mutants thus may be simulated by one mutant when raised at different temperatures.

By appropriate transfers of larvae from one temperature to another at different times in different individuals, it is possible to locate in the life cycle the exact period during which temperature has a differential effect. This effective period comes in the third instar of the larva, has definite limits and is of short duration. The temperature of the developing individual at other times in its life cycle has no effect upon the number of facets in the adult eye. If we assume that the different physiological processes involved in the development of the eye have different temperature coefficients the differences in adult facet numbers of individuals raised at different temperatures are explained.

Changes in the bar-gene may be postulated to produce changes in the relative rates of the processes acting during the effective period and thus bring about changes in the temperature coefficients of the mutants and may even reverse the effect. A study of the nature of the difference in developmental processes produced by the different genes of such a series of mutations is likewise an avenue of approach to knowledge of the structure of the gene and the nature of gene action.

Since the circumstances connected with the production of the bar mutants make it possible to formulate a theory of difference between the genes of the series in terms of structural change, quantitative in some cases, and since the resulting somatic effects may be measured in terms of temperature effect upon an individual with unchanged genes, it seems worth while to postulate, for purposes of experimental test, theories of gene action in terms of relative rates of the physiological effects they produce.

Conclusion

In conclusion, let us return to the original thesis, of the need of recurring cycles of inbreeding and outbreeding for sound scientific progress. Daring explorations on the embryological frontier of genetics, long considered by many geneticists as wild and dangerous speculations, are gaining ground as legitimate enterprises. Some of the results of these explorations are receiving attention. Both genetics and embryology are profiting by the functional contact. Fears that the "organizer" of the embryologist might destroy the gene or that the gene might inactivate the "organizer" are turning out to be groundless. Both concepts have passed their immature periods in isolation; they are now mature, and the union is a fertile one. It will serve no good purpose to brand the offspring as illegitimate.

OBITUARY

EDWIN CHAPIN STARKS

EDWIN CHAPIN STARKS, associate professor of zoology emeritus in Stanford University, died at his home in Palo Alto, California, on December 29, 1932. He was born in Baraboo, Wisconsin, on January 25, 1867, and spent his youth mainly in Chicago, where he received his early education, and afterward engaged in business. With an inborn interest in living things he was especially attracted by fishes, and early set about finding out all he could concerning them. He collected specimens of all that came within his range, mounted most of them in a remarkably skilful manner, and found out their names and relationships, searching all available libraries to do so. He entered into correspondence with Dr. Theodore Gill, of the U. S. National Museum, and with Dr. David Starr Jordan, then president of the University of Indiana. His eager inquiries received cordial welcome and prompt response from each of these great naturalists. To Dr. Gill may be traced his interest in the osteology of fishes, which later became his main field of study. Dr. Jordan encouraged him as he alone could, and the avocation of the boy and young man soon became the fixed ideal of his life. In 1893 he entered Stanford University as a special student in zoology, and quickly found a welcome in the enthusiastic group in that department under the guidance of President Jordan and Professor C. H. Gilbert. His definite purpose was to become a zoologist, an authority in the field of ichthyology, and nothing swerved him an instant from that goal. Things which did not bear directly upon this end he banished from his program without hesitation as useless distractions. The then existing major subject system at Stanford made possible a concentration of study and effort rarely found open to-day, especially for the so-called "special student," now almost standardized out of existence. He never took the trouble to fulfil the routine entrance requirements, and thus to become a regular student, nor to qualify for a degree. In such matters and in formal courses he was not interested. The privileges of laboratory, scientific collections and library, the sympathetic advice and guidance of able and inspiring teachers, the daily contact with a select number of ambitious associates gave him all the opportunities he desired. Equipped with an alert and naturally keen mind, and with powers of concentration far above the average, he soon justified the confidence placed in him.

In December, 1894, he accompanied Dr. Jordan and several other students on a zoological collecting trip to Mazatlán, Mexico, the first of many such field journeys in which his love of travel and adventure and of the study of living things in their natural surroundings was to have full range. The following summer he took part in an exploration of Puget Sound, headed by Professor Meany, of the University of Washington, in which the first systematic dredging in that body of water was undertaken. Back at Stanford in the fall, he again left in December, 1895, for southern waters, this time with Dr. C. H. Gilbert on the Stanford Expedition to Panama, where four months were filled with intensive field work upon the fishes of that region.

He was married in June, 1897, to a fellow Stanford student, Miss Chloe F. Lesley, who later also became a member of the faculty, and as associate professor of graphic art was retired in 1932. Their daughter, Dr. Dorothy J. Starks, is now an instructor in radiology in the Stanford University School of Medicine.

In 1897 he was appointed to an assistantship in the U. S. Biological Survey under Dr. C. Hart Merriam at Washington, where he spent two busy years. An opportunity to join the Harriman Expedition to Alaska in the summer of 1899 was eagerly seized, as it opened a new field of experiences and an excellent opportunity for acquaintance with the noted group of scientists taking part in it. On his return he became curator of the museum and assistant professor of zoology in the University of Washington. In 1901 he was called to Stanford as curator of zoology, was made assistant professor in 1907, and associate professor in 1927, in which capacity he served until his retirement in 1932.

In 1904 Professor Starks took part in a field trip for the U. S. Bureau of Fisheries in Oregon, under the leadership of Professor J. O. Snyder. In 1910 the Stanford Expedition to Brazil, headed by Professor J. C. Branner, gave him an opportunity to become acquainted with its northern and northeastern coasts and to make extensive collections of fishes there. A trip to Europe in 1907 to visit museums and to form personal contacts with zoologists, whom he had already known through correspondence and exchange of publications, was followed by a longer one with his family in 1913 and 1914, a part of which was spent in research in the Zoological Station at Naples and in museum work, the remainder in travel and in art studies.

The summers of 1909 and 1912 found him again on the waters of Puget Sound, in the former year as instructor in zoology at the Friday Harbor Marine Laboratory, in the latter as an investigator there. In the summer and fall of 1926 he made his last long collecting trip, a private one undertaken to the Philippines to secure certain forms for osteological study not otherwise procurable.

Throughout all these years and almost up to the very end of his life his scientific writings steadily appeared, the total number reaching more than eighty. Based upon each of the above expeditions were extensive reports dealing with faunistic and distributional results, either written by himself alone, or in collaboration with Dr. Jordan, Dr. Gilbert or others. The most notable of his many publications deal with the comparative osteology of fishes, in which he became a recognized authority. His careful analytical studies in this difficult field have thrown much light on the relationships of a large number of genera and families, and have furnished a solid basis for their classification. Not a little of the value of this series of studies is due to the unfailing cooperation of his wife, Mrs. Chloe Lesley Starks, whose superb artistic skill and accuracy provided his papers with illustrations not to be excelled anywhere.

Professor Starks was a life member of the California Academy of Sciences, to the *Proceedings* of which he contributed many important papers. He was also a corresponding member of the Zoological Society of London and a fellow of the American Association for the Advancement of Science.

As a teacher he was exceptionally gifted. His broad sympathy with students, his patience and clarity in exposition, his contagious enthusiasm, and his kindly humor won the affection and admiration of all his pupils. As a colleague he held a high place in the estimation of his faculty associates. His modest, retiring disposition led him to shun publicity, but his constant and generous hospitality within his own home drew around him a group small but unusually devoted.

Apart from his scientific work Professor Starks' interests were many and varied. Although a naturalist he found no pleasure in hunting or angling, but took the greatest delight in outdoor life, and in travel contacts with other places and peoples. He was an avid reader and his well-selected library gave evidence of his breadth of interest in the best in literature and art. His usual recreation was sought in his workshop, and from it issued from time to time artistic and beautiful products of his craftsmanship in wood and metal that were the wonder and envy of his friends. Photography and fine printing were also hobbies in which he excelled. His experiences and observations on each of his many expeditions were carefully recorded in separate journals, illustrated with sketches and photographs. Three of these, his own printing and binding, models of fine bookmaking, are highly prized by those of his friends who were fortunate enough to receive copies.

A broad appreciation of the beautiful in nature, in life, literature and art enriched his years. Upon his release from teaching responsibility he looked forward to continued activity in research and travel. But it was not to be. Never robust physically, an increasing cardiac weakness terminated his life after a short illness. His scientific writings will stand as a memorial to his exact and painstaking industry and high scholarship, his former pupils, his colleagues, and his friends will cherish still more the memory of a kind and joyous personality, sincere and faithful to the end.

F. M. MACFARLAND

STANFORD UNIVERSITY

HERMAN THEODOR HOLM

DR. HERMAN THEODOR HOLM, who was on the staff of the Department of Agriculture for several years and who was connected with the department in various phases of scientific work for many years, passed away at Providence Hospital, after a brief illness, on December 26, 1932.

Dr. Holm was born in Copenhagen, Denmark, on February 3, 1854, and graduated under Warming from the University of Copenhagen in 1880. He was appointed to the Denmark North Polar Expedition in 1882 as botanist and zoologist under Admiral Garda and for some two years was icebound in Greenland. He added greatly to the botanical knowledge of West Greenland, and his extensive knowledge of altitude and circumpolar floras compelled attention of all interested in this subject.

On April 12, 1888, Dr. Holm landed in New York City, and as soon thereafter as possible applied for citizenship. He enjoyed telling that he was an American by choice and that we "could not help ourselves." Very soon after coming to this country he was appointed assistant botanist in the U. S. National Museum and occupied that position from 1888 to 1893, and was then appointed assistant pathologist in the U. S. Department of Agriculture. In 1897 he resigned this position, but, as above stated, he did much work for the department in connection with special botanical problems, drawing, and translating. For drawings that show the anatomy of plants he had no peer, and he read and translated all the Teutonic languages and many Latin languages. So wedded was he to his scientific work that some years ago he moved to an isolated farm in Maryland in order to have uninterrupted time for his work, but was finally persuaded to accept a position on the research staff of the Catholic University of America, where he was given ample room for his collections. Many of his papers were published in Germany. It seems regrettable that American botany should come to us through translation.

Although wedded to his profession Dr. Holm was

a gracious host. He gave many interesting small dinners and could cook on occasion. He took infinite pains to help good work, but for pretense and bad work his criticisms were devastating.

A. F. WOODS

U. S. DEPARTMENT OF AGRICULTURE

RECENT DEATHS

JAMES M. WHITE, professor of architectural engineering and supervising architect of the University of Illinois, died on February 6, at the age of sixty-five years.

SAMUEL ANTHONY GOLDSCHMIDT, chemist, chairman of the Board of Directors of the Parsons Ammonia Company, died on January 29, at the age of eighty-four years.

DR. RONALD STEELE SADDINGTON, an assistant on the scientific staff of the Rockefeller Institute, died at the Rockefeller Institute Hospital on February 4, of an illness contracted three weeks ago while studying herpes. He was twenty-nine years old.

SAMUEL W. PHILLIPS, in charge of the erosion station of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture at Zanesville, Ohio, was shot and killed by a burgler in his home on January 23. Mr. Phillips was in his thirty-ninth year.

SIR J. ARTHUR THOMSON, emeritus professor of natural history at the University of Aberdeen, died on February 12 at the age of seventy-two years.

SIR DANIEL MORRIS, scientific adviser in tropical agriculture to the British Colonial Office, previously from 1898 to 1905 imperial commissioner of the West Indies Department of Agriculture, died on February 9 at the age of eighty-eight years.

SIR FREDERIC G. HALLETT, secretary of the Imperial Cancer Research Fund and formerly secretary of the conjoint board of the British Royal College of Physicians and Surgeons, died on February 6. He was seventy-two years old.

THOMAS ALFRED COWARD, the British ornithologist, died on January 30, at the age of sixty-six years.

AUGUSTIN MESNAGER, civil engineer, vice-president of the Paris Academy of Sciences, died on February 6. He was seventy years old.

SCIENTIFIC EVENTS

INTERNATIONAL VITAMIN STANDARDS

THE international standards for vitamins A, B (B_1) and D, which have been allotted to this country, have been received by Dr. E. M. Nelson, Protein and Nutrition Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C. These standards are made available to investigators in the United States through the generosity of the Health Organization of the League of Nations. Application blanks for obtaining the standards, which will be distributed for scientific purposes, can be obtained from Dr. Nelson. These standards were designed for the sole purpose of enabling investigators to express vitamin potency in units of universally accepted value. The quantities distributed are suitable only for assay with small laboratory animals, such as rats, pigeons and mice. In order to make the best use of these primary standards it is suggested that investigators give consideration to the possibility of making suitable secondary standards through the use of the material distributed.

Allotments of international standards have been deposited with Dr. E. Fullerton Cook, chairman of the U. S. Pharmacopoeia Revision Committee, 43rd Street and Woodland Avenue, Philadelphia, Pennsylvania, for distribution for research purposes and for the standardization of a U. S. Pharmacopoeia reference cod liver oil. The U. S. Pharmacopoeia reference cod liver oil, a secondary standard for vitamins A and D, is to be available to all applicants at small cost and is intended to serve particularly for establishing new and more desirable definitions for vitamin potency of U. S. Pharmacopoeia cod liver oil. The U. S. Pharmacopoeia reference cod liver oil will also serve as a suitable standard for all products for which claims for vitamins A and D potency are to be made. An announcement concerning this reference cod liver oil will be made by the U. S. Pharmacopoeia Revision Committee.

HENRY G. KNIGHT

THE MORRIS ARBORETUM

APPOINTMENTS to the executive and scientific staffs of the Morris Arboretum of the University of Pennsylvania, at Chestnut Hill, have been announced.

Dr. Rodney H. True, professor of botany and director of the botanical gardens at the University of Pennsylvania since 1920, has been made director of the arboretum. Before going to Pennsylvania he was plant physiologist of the U. S. Department of Agriculture in charge of physiological investigations and also served at various times on the faculties of Radcliffe College, the University of Wisconsin and Harvard.

James Lambert, superintendent of the botanical gardens at the university for a number of years and

a graduate of Kew Gardens in London, has been named superintendent of the arboretum, and the position of head gardener has been filled by the appointment of John Tonkin, who was head gardener under Miss Morris. James O'Neill, who also was in the employ of Miss Morris, will be custodian. A secretary, whose appointment will complete the executive staff, will be named later.

Four members of the faculty of botany have been appointed to the scientific staff. They are Professor Harlan H. York, pathologist; Associate Professor Edgar T. Wherry, ecologist; Associate Professor Conway Zirkle, geneticist, and Assistant Professor John M. Fogg, Jr., taxonomist.

Dr. York will carry on research investigations in connection with plant diseases, with particular reference to trees. Prior to becoming a member of the university faculty, Dr. York served as expert in charge of the research program in the forestry project of the New York State Department of Conservation.

As ecologist, Dr. Wherry will direct the study of plants in their relation to soil and atmospheric conditions and the relation of plants to each other in mixed plantings.

Dr. Zirkle, who is a former member of the research staff at Harvard University, will be associated chiefly with special studies of the reproductive processes in higher plants, particularly with reference to the processes concerned in inheritance.

Dr. Fogg will be in charge of the identification and grouping of the plants in the arboretum on the basis of their botanical relationship. It is the intention to assemble at Compton the most complete herbarium of woody plants that it is possible to collect from all parts of the world.

In addition to the executive and scientific staff, the organization of an advisory staff, which will include a landscape architect, a zoologist, a chemist and an engineer, has been recommended by the committee on administration of the arboretum, of which Dr. George Wm. McClelland, vice-president of the university in charge of the undergraduate schools, is chairman. The members of the advisory staff will be designated by the respective deans or department heads, subject to the approval of the committee on administration.

THE PROPOSED EVERGLADES NATIONAL PARK

WE are permitted to print the following memorandum addressed on January 7 by Dr. Wilbur, Secretary of the Interior, to Horace M. Albright, director of the National Park Service:

With the help of Dr. Fairchild and Judge Ritter, president of the association, and through the kindness of Mr. Henry L. Doherty, I was taken to Cape Largo, then by water through the Keys to Cape Sable, then to the mouth of the Shark River, up the Shark River through the Ten Thousand Islands to Everglades, and then along the Tamiami Trail, both west and east. The map of which I was sent a copy was most helpful. When additional copies are available, I should like to have them sent to Messrs. Doherty, Ritter and Fairchild.

This area has outstanding qualifications for national park status. It should be maintained as a water or marine park and a wide area should be taken in. Every effort should be made to keep this a primitive area. I think roads should not be built through it, but that the road which now goes down to the Middle Beach and the Cape Sable area, should be improved, and this region should be the southern entrance to the park. The northern entrance should be at Everglades. All visitors to the remote areas of the park should go by water. As few trails as possible should be built. These can be of simple construction, using elevated planks. This would avoid the mud with the change in tides, snakes, etc.

The protection of the park can be brought about by rangers with small boats, and by an autogiro. It is evident that the proper development of this park will not be costly and that the cost of its control and management can be kept down to figures that will be largely met by the usual reasonable entrance fees.

I need not describe the beauty of the mangrove forests, the unusual opportunities for education and inspiration as well as recreation, the marvelous bird flights, etc. These have been amply covered before.

The one thing that worries me most is the maintenance of a fresh-water supply into the upper reaches of the Shark and other rivers so that there will be no encroachment of salt-water. Such encroachment would destroy the most unique qualities of the park. This means that a wide area to the north must be kept in a virgin condition and that no cross canals interfere with the general drainage of water from Lake Okeechobee south.

It seems to me to need prompt action by Congress, so that large funds for the purchase of these lands can be obtained from private or state sources, and so that there will not be too many small areas to purchase. There is a tendency to bring into production land that should be allowed to remain in its primitive condition.

IN HONOR OF DR. ELIHU THOMSON

PRELIMINARY plans have been announced for a dinner on March 29, at which leaders in science, engineering and industry will honor Dr. Elihu Thomson, the distinguished engineer and inventor, upon the occasion of his eightieth birthday. The dinner is to be held at the Massachusetts Institute of Technology, of which Dr. Thomson was acting president from 1920 to 1922, and of which he is a life member of the corporation.

International in its significance, the dinner will bring together distinguished representatives of the electrical industry, to which Dr. Thomson has made so many important contributions, leaders from educa-

tional institutions, and officers of the various scientific academies, professional societies and technical organizations.

Preliminary plans for the tribute to Dr. Thomson provide for an afternoon conference on topics significant to the occasion. These include the historical development of the applications of electricity, the recent experimental trends and the latest theories of electricity and matter. In connection with this meeting, plans are being made for an impressive exhibit of many of Dr. Thomson's inventions and contributions in the electrical field.

The committee in charge of arrangements consists of the following:

Professor Dugald C. Jackson, head of the department of electrical engineering at the institute, *chairman;* Professor Gustav C. Dahl, of the same department, *secretary;* Dr. Charles G. Abbot, secretary of the Smithsonian Institution; Dr. James Rowland Angell, president, Yale University; Dr. William W. Campbell, director, Lick Observatory, and president, the National Academy of Sciences; Harry P. Charlesworth, vice-president of the Bell Telephone Laboratories, Inc., and president of the American Institute of Electrical Engineers; Dr. Karl T. Compton, president, the Massachusetts Institute of Technology; Dr. Harvey Cushing, Moseley professor of surgery, emeritus, Harvard University; Nelson J. Darling, manager, river works, General Electric Company; Alexander Dow, president, Detroit Edison Company; Dr. Paul D. Foote, director, Research Laboratory of the Gulf Production Pipe Line Companies; Honorable William C. Forbes; Professor Jeremiah D. M. Ford, Harvard University, president, American Academy of Arts and Sciences; Dr. Thomas S. Gates, president, University of Pennsylvania; Dr. George E. Hale, director, Mount Wilson Observatory; Nathan Hayward, president, the American Dredging Company; Dr. Frank B. Jewett, vice-president, the American Telephone and Telegraph Company; Dr. Arthur E. Kennelly, of Harvard University, president, the Union Radio Scientifique Internationale; John C. Lincoln, chairman, board of directors, the Lincoln Electric Company; Dr. Arthur D. Little, president, Arthur D. Little, Inc.; Dr. A. Lawrence Lowell, president, Harvard University; Dr. Roland S. Morris, president, American Philosophical Society; Dr. Calvin W. Rice, secretary, American Society of Mechanical Engineers; E. Wilbur Rice, Jr., honorary chairman of the board, General Electric Company; Andrew W. Robertson, chairman of the board, Westinghouse Electric and Manufacturing Company; Albert L. Rohrer, formerly of the General Electric Company; Clayton H. Sharp, vice-president and technical adviser, Electrical Testing Laboratories, and chairman, U. S. National Committee of the International Electrotechnical Commission; Ambrose Swasey, chairman of the board, Warner and Swasey Company; Gerard Swope, president, the General Electric Company, and Edwin S. Webster, president, Stone and Webster.

SCIENTIFIC NOTES AND NEWS

PRESIDENT HERBERT HOOVER has been elected an honorary member of the British Institution of Civil Engineers.

BRITISH New Year's honors included the title of baron, conferred on Sir Thomas Jeeves Horder, senior physician to St. Bartholomew's Hospital.

A MEETING in memory of John J. Carty, vice-president of the American Telephone and Telegraph Company, who died on December 27, was held at Rollins College on February 9. The speakers were Dr. Frederick P. Keppel, president of the Carnegie Corporation of New York; Thomas A. Watson, who was associated with Alexander Graham Bell in the invention of the telephone, and Dr. David G. Fairchild, of the U. S. Department of Agriculture. Dr. Carty was a trustee of Rollins College.

THE Cameron Prize of the University of Edinburgh has been awarded to Dr. George F. Dick, professor of clinical medicine at Rush Medical College, Chicago, and Dr. Gladys H. Dick, fellow of the John McCormick Institute for Infectious Diseases, in recognition of their work on the etiology and treatment of scarlet fever. The award is made annually "to a person who, in the course of the five years immediately preceding, has made any highly important and valuable addition to practical therapeutics."

JAMES ORR ELTON, since 1921 manager of the International Smelting Company at Salt Lake City, has been awarded the James Douglas Medal for 1933 of the American Institute of Mining and Metallurgical Engineers. The award, the highest in the metallurgical field, was established in memory of Dr. James Douglas, who was largely responsible for the development of copper metallurgy in Arizona. The medal was conferred on Mr. Elton for his work in the treatment of smelter fume and in the production of electrolytic zinc; for the development of methods for preferential flotation of lead-zinc-silver ores and oxidized lead-silver ores; and for improvements in lead smelting. Presentation of the medal will be made at a meeting of the institute on February 22.

THE council of the British National Institute of Agricultural Botany has awarded the Snell Memorial Medal for 1932 to Dr. Kenneth M. Smith, entomologist of the Potato Virus Research Station of the University of Cambridge. The medal is given to

Dr. Smith in recognition of his valuable research work on the virus diseases of the potato.

THE Stephen Hales Prize of the American Society of Plant Physiologists has been awarded to Dr. Hubert Bradford Vickery, of the Connecticut Agricultural Experiment Station, for his work on vegetable proteins.

THE gold Paul-Ehrlich Medal has been awarded to Dr. Paul Uhlenhuth, professor of hygiene and bacteriology at the University of Freiburg, Baden.

THE Bernhard-Nocht Medal has been awarded to Dr. Hans Ziemann, professor of parasitology at the University of Berlin.

THE Swedish Medical Society has awarded the Gullstrand Gold Medal to Priestley Smith, emeritus professor of ophthalmology at the University of Birmingham, England, for his "ophthalmological researches, especially regarding glaucoma and the permanent growth of the lens."

DR. LOUIS MARTIN, subdirector of the Institut Pasteur and director of the Hôpital Pasteur, Paris, has been nominated Grand Officer of the Legion of Honor.

DR. FRIEDRICH VON MÜLLER, professor of internal medicine at Munich, celebrated on December 30 the fiftieth anniversary of his doctorate.

PROFESSOR EDWARD R. SCHWARZ, of the department of mechanical engineering at the Massachusetts Institute of Technology, has been elected to a fellowship in the British Textile Institute in recognition of his "notable contributions in the field of textile technology and research."

JOHN CLYDE HOSTETTER, director of research and development of the Corning Glass Works, New York, has been elected president of the American Ceramic Society, which opened its thirty-fifth annual convention in Pittsburgh on February 13. Mr. Hostetter succeeds Emerson P. Poste, consulting engineer of Chattanooga, Tennessee. Louis J. Trostel, of the General Refractories Company, Baltimore, has been made vice-president, replacing W. Keith McAfee, of the Universal Sanitary Manufacturing Company, New Castle, Pennsylvania.

CAPTAIN CHARLES M. OMAN has been appointed surgeon-general of the U. S. Navy, succeeding Rear Admiral Charles E. Riggs, whose term expired on January 19.

DR. RALPH HARTLEY WETMORE, assistant professor of botany at Harvard University, has been appointed director of the Botanical Laboratories.

DR. J. B. S. HALDANE has resigned from the Sir William Dunn readership in biochemistry at the University of Cambridge, to accept a chair in the University of London.

DR. NATHANIEL T. KIDDER was elected president of the Massachusetts General Hospital at the annual meeting of the corporation on February 1.

Museum News reports that an informal committee to advise on opportunities for service in building up Canadian museums has been formed by the Carnegie Corporation, following recommendation of Sir Henry Miers and S. F. Markham. The members of the committee are Eric Brown, director of the National Art Gallery, Ottawa; H. O. McCurdy, assistant director of the National Art Gallery; E. L. Judah, director of the Ethnological Museum, McGill University; J. C. Webster, of Shediac, New Brunswick, and Francis Kermode, curator of the Provincial Museum at Victoria.

DR. JAMES ANGUS DOULL, president of the Western Reserve University chapter of Sigma Xi, has announced the election of the following new members from the faculty of the School of Medicine: Dr. Carl H. Lenhart, professor of surgery; Dr. Claude S. Beck, assistant professor of surgery; Dr. Norman C. Wetzel, assistant professor of pediatrics; Dr. Rafael Dominguez, associate in pathology, and Dr. Carrol G. Barber, fellow in anatomy.

DR. HERMA PLANTENGA, specialist in plant pathology at the laboratory of Professor Dr. Johanna Westerdyk, at Baarn, Holland, is at present in the United States as a volunteer worker at the new division of plant pathology of the Rockefeller Institute at Princeton.

PROFESSOR N. I. VAVILOV, president of the Lenin Academy of Agricultural Sciences and director of the Institute of Plant Industry, Leningrad, is visiting the United States on his way from a trip to South America. Professor Vavilov is especially interested in the economic grasses and their relation to the development of civilization.

DR. ELLSWORTH HUNTINGTON, research associate in geography at Yale University, lectured before the Franklin Institute on February 9, on "A Theory of Civilization and Climate."

DR. CHARLES R. STOCKARD, professor of anatomy and director of the Experimental Morphology Farm at Cornell University, began on February 14 a series of lectures at the New School for Social Research, New York City, in which he will discuss "The Modern Analysis of Living Structures and Behaviors." Under this general heading, he will give fifteen weekly lectures.

THE twenty-fourth Kelvin lecture of the Institution of Electrical Engineers will be delivered by Sir Frank

Smith, secretary of the British Department of Scientific and Industrial Research, on April 27. The title of the lecture will be: "The Travel of Wireless Waves."

THE HENRY RUSSEL LECTURESHIP at the University of Michigan for 1933 has been awarded to Professor Walter B. Pillsbury, head of the department of psychology. The lectureship was established ten years ago by the late Henry Russel, who left $10,000 for the purpose. The income from the fund is divided into two sums, one being devoted to the lectureship and the other to the Henry Russel award. The latter will go to a faculty member, ranking not higher than assistant professor and showing promise of unusual talent.

AN inaugural banquet of the Smith-Reed-Russell Society of the School of Medicine, George Washington University, was held at the University Club on the evening of January 13, at which time guest speakers included Dr. Theobald Smith and Dr. Frederick F. Russell, two of the three investigators in honor of whom the society is named. Other speakers included the president of the university, Dr. Cloyd Heck Marvin, and Colonel Albert E. Truby, who received the key of the society for Walter Reed to transmit to Colonel Walter L. Reed, surviving son.

Nature reports that spring lectures at the Royal Institution are planned as follows: The session of public afternoon lectures at the Royal Institution was opened by Professor J. C. McLennan, who is giving an experimental course on the work on "Low Temperatures and Low Temperature Phenomena" with which he and the University of Toronto have been specially identified. A course on "Recent Advances in Genetics" is to be given by Professor J. B. S. Haldane, who recently returned to England from a visit to the United States. Later courses are by Sir William Bragg, who will review the progress in the past twenty years of the science of crystal analysis by x-rays, and Mr. A. R. Hinks, secretary of the Royal Geographical Society, on "Geography in the Public Service." Mr. Hinks will speak on the new one inch Ordnance Survey map, and the delimitation of national boundaries. Lord Rutherford will give a Saturday course on the "Detection and Production of Swift Particles." The course will be experimental, and as a part of his subject Lord Rutherford will describe the recent progress at the Cavendish Laboratory by Chadwick, Cockcroft and Walton and others. Sir James Jeans will give a course on "Modern Astronomy." The new Fullerian professor of physiology at the Royal Institution, Professor G. Elliot Smith, will give a course on the "Evolution of the Mind."

THE Federal Club, an organization of officials of the Federal Government and the government of the District of Columbia, having as its purpose the advancement of standards of administration and of personnel and the promotion of cooperation and efficiency in the business of government, appointed Dr. W. W. Stockberger, director of personnel and business administration of the U. S. Department of Agriculture, as member and chairman of its membership committee at a meeting held at the Cosmos Club in Washington on January 18. Other members appointed to this committee are E. C. Crittenden, chief of the electrical division of the Bureau of Standards, and E. C. Babcock, secretary of the United States Civil Service Commission. Albert K. Brown, Bureau of Fisheries, was elected a director, to succeed Commander H. A. Seran, Coast and Geodetic Survey, who has been detailed to duty at sea. Edgar B. Calvert, chief of the forecast division of the Weather Bureau, is now president of the club.

Nature states that the work, extending over the past two years, of various preliminary committees was brought to a conclusion on January 3 when the Institute of British Geographers held its first meeting and elected a council and officers. The initial membership is open to all present members of the staffs of university departments of geography in Britain; in the future, membership will be by election. With one possible exception, all universities, as well as a large number of colleges of university rank, in Great Britain have now departments of geography and there is thus an obvious need for coordinating the teaching and research work of their staffs and for permitting an exchange of views on matters of particular interest in the furtherance of the subject in the universities. The council and officers elected are: *President,* Professor C. B. Fawcett, University College, London; *Honorary Secretary and Treasurer,* Mr. A. A. Miller, Reading; *Honorary Assistant Secretary,* Dr. H. A. Matthews, Birkbeck College, London; *Council,* J. N. L. Baker, Oxford; Dr. R. O. Buchanan, University College, London; Professor H. J. Fleure, Manchester; Professor Ll. Rodwell Jones, London School of Economics; Professor P. M. Roxby, Liverpool, and Dr. S. W. Wooldridge, King's College, London.

THE London *Times* reports that a new scientific expedition to the Antarctic has been undertaken by Captain Riiser Larsen, who left London recently with several friends for the shores of Enderby Land. According to present arrangements, the exploring party will consist of Captain Larsen and two other men, who will join him and his friends in South Africa. From there they will board a tanker belonging to Consul Lars Christensen, and will make the 11-days trip to Enderby Land, which they expect to reach some time in February. There the three ex-

plorers will land with their supplies and 100 dogs, and for a year will make a close study of the coast of the Weddell Sea. Captain Larsen accompanied Amundsen's 1925 Arctic Expedition.

EARLY in January, according to *Museum News*, the Rochester, New York, Museum of Arts and Sciences was voted an additional $9,000 appropriation by the city council and will remain open. For a time the financial crisis in the city, which was receiving only a limited income from taxable property and had 50,000 welfare cases to care for, threatened to close the museum and Director Arthur C. Parker had tendered his resignation. With the added appropriation the museum is to continue its work; and at the request of the city museum board Mr. Parker has agreed to remain in charge.

THE committee of the American Psychological Association on Precautions in Animal Experimentation, consisting of Drs. C. P. Stone, E. G. Wever and C. J. Warden, *chairman*, desires to call attention to the following bills which have been introduced since January first to limit experimental work on animals: (1) New York Assembly, A. 63, proposing to prohibit any experimental work upon a living dog; (2) New York Assembly, A. 181, proposing to make it a misdemeanor to experiment or operate on a live dog for any purpose other than to heal or cure the animal; (3) Massachusetts Senate, S. 113, proposing to penalize certain experiments and operations on live dogs, and (4) Maine House, H. 217, proposing a fine for the practice of vivisection in schools supported wholly or in part by the state. Dr. Warden writes: "It is hoped that members of the American Psychological Association, residing in these states, will write letters of protest against the passage of these measures to the appropriate legislators. Bills of this kind are backed by powerful organizations whose efforts to obstruct scientific research must be met by active and determined resistance."

THE printed *Proceedings* of the Land Use Symposium, held at the summer meeting of the American Association for the Advancement of Science at Syracuse University, have just been issued. They contain all the papers presented at the meeting, which was well attended by economists, business men, research workers, foresters, agronomists, geographers and representatives of other earth sciences. Among the subjects treated in the *Proceedings* are the activities of the National Land Use Committee, Land Use and Agriculture, Land Use and Forestry, Land Use and Erosion, Land Use and Transportation, The Relation of Taxation to Land Utilization and Planned Land Use. The speakers included Dr. L. C. Gray, secretary of the National Land Use Planning Committee, Washington, D. C.; Dr. G. F. Warren, head of the Department of Agricultural Economics and Farm Management, Cornell University; Dr. F. P. Weaver, head of the Department of Agricultural Economics, Pennsylvania State College; Dr. Joseph S. Illick, head of the Department of Forest Management, New York State College of Forestry, Syracuse University; Mark Graves, director of the budget of the State of New York; Dr. Jacob G. Lipman, dean and director of the New Jersey Agricultural Experiment Station; Dr. Henry G. Knight, chief of Bureau of Chemistry and Soils, U. S. Department of Agriculture; Dr. Charles L. Raper, dean of the College of Business Administration, Syracuse University; L. R. Schoenmann, in charge of the Michigan Land Economic Survey. The *Proceedings* are arranged in a 60-page bulletin of standard book size, which can be procured from the Department of Forest Management, New York State College of Forestry, Syracuse, N. Y.

DISCUSSION

A NEW MATHEMATICAL FORMULA FOR CHEMICAL ANALYSIS IN A TWO PHASE SYSTEM[1]

OWING to the depression, the biochemist may be faced with a reduction in floor-space and budget, and, hence, one piece of apparatus may have to serve for a number of analytical procedures. I have shown[2] that the Bausch and Lomb micro-colorimeter may be used for the analysis of over 60 substances.

In many analytical procedures, the titration of a substance in water solution in the presence of large quantities of impurities leads to error which is greater the greater the ratio of the impurities to the "unknown."

In colorimetric analysis, colored impurities may often be ruled out by the use of monochromatic light that transforms the colorimeter into a spectrophotometer. Luminous, rarefied-vapor-tubes giving bright line spectra may be easily obtained, and color-filters used to filter out all bright lines except the one desired.

Impurities may not have worried chemists who were analyzing large samples of the unknown substance. But as the methods are adapted to smaller and smaller quantities of the "unknown" without a proportional reduction in the impurities, side-reactions which were insignificant in the older work become significant to the micro-chemist.

[1] From the University of Minnesota and Tohoku Imperial University.

[2] McClendon, "A System of Microchemical Analysis, Handbook of Experimental Chemistry." (1st ed., Japanese and English) Kyo-rytsu-sha, Tokyo, 1932.

A method that has long been used for getting rid of impurities is the extraction of the "unknown" from water-solution with CCl_4 or other non-miscible solvent. (Chloroform and CS_2 spontaneously decompose in storage and CS_2 is highly volatile and inflammable.) In case the partition-coefficient CCl_4/H_2O is 200 or higher, some chemists have assumed that all the "unknown" is extracted with one extraction.

If the substance is colored, it may be determined directly in the colorimeter, and this is easier than getting it back into water to determine it by titration; and is just as accurate, if 10 readings of the colorimeter are made (finding the average being simply addition and moving of the decimal point). If the unknown solution is set at unit depth the colorimeter readings of the standard give the concentration of the unknown *directly,* without any calculation whatever (assuming the standard is in unit concentration).

In case the partition-coefficient, CCl_4/H_2O, is small enough to make repeated extractions necessary, the work becomes very laborious, owing to the fact that an infinite number of extractions are necessary to remove all the "unknown" from water-solution. If the partition-coefficient is known, the total "unknown" may be calculated from one extraction (knowing the ratio of volumes of the water-solution to the CCl_4). But the presence of impurities may alter the partition-coefficient to an unknown extent.

I have worked out a formula for calculating the total "unknown" from 2 extractions. It is not necessary to know the ratio of volumes of the water-solution to the CCl_4, but the ratio must be the same in the 2 extractions. The extraction is made in a separatory funnel and all the CCl_4-extract and none of the water-solution is removed. The funnel is stoppered and inverted and the water-solution in the hole in the stop-cock allowed to run back into it before admitting CCl_4 for the second extraction. If

x = total,
x_1 = 1st extract and
x_2 = 2nd extract

the formula is:

$$x = x_1 + \frac{x_1\, x_2}{x_1 - x_2} \quad \text{or} \quad x = x_1 + \frac{x_2}{1 - \frac{x_2}{x_1}}$$

J. F. MCCLENDON

GROWTH RETARDATION BY THE PARTIALLY OXIDIZED SULFHYDRYL OF CYSTEINE

IN the spring of 1930, I presented before the American Philosophical Society the experimental data leading to the postulate that growth by increase in cell number is regulated by a naturally occurring chemical equilibrium comprised of sulfhydryl as the accelerating portion and its partially oxidized derivatives as the retarding. The full report was published in *Protoplasma,* Vol. 11, pp. 383–411, in the same years.

At that time I recognized that complete validation of the postulate depended upon the demonstration of cell proliferation inhibiting properties by a partially oxidized derivative of the sulfhydryl group carried by a naturally occurring sulfur compound.

Since I had found that cysteine, cystin and glutathione (a cysteine-containing compound) all accelerated cell multiplication, and since these compounds occur naturally in living growing things, the obvious thing to do was to use a partially oxidized sulfur derivative of one of these compounds.

Such a derivative was not available nor had it ever been prepared, to my knowledge. I therefore gave this chemical problem over to Dr. Gerrit Toennies, chief of the chemical division of our institute. After three years of concentrated effort he has succeeded in producing and isolating a sub-oxidized sulfur derivative of cysteine, starting with cystin. This is a notable achievement. He himself will make the report of his method and the chemical properties of the product elsewhere. Suffice it to say here that his tests show the compound to be neither an SH combination nor cysteic acid, the completely oxidized sulfur derivative, but some intermediate stage.

For practical purposes, I had postulated in the paper referred to above that the compound must be water soluble, essentially neutral and fairly stable in aqueous solution for a reasonable period. Dr. Toennies has produced a compound which meets these requirements.

With the material which he has supplied me I have tested out its action on the growth of Hydra hydranths and the embryonic development of Crepidula eggs and larvae. Uniformly have I found that definite and marked retardation is produced by this partially oxidized sulfur derivative of cysteine, a naturally occurring sulfur-containing compound. The retardation is produced by a concentration of about one part per million sulfur in the sub-oxidized state. This concentration is of the same order of magnitude as that used for sulfoxide in previous experiments and which was found similarly retardative.

This finding, therefore, demonstrates for the first time the growth-inhibiting effects of partially oxidized sulfhydryl from naturally occurring compounds and thus puts on unequivocal foundation the postulate that growth by increase in cell number is regulated by the naturally occurring chemical equilibrium comprised of sulfhydryl and its partially oxidized derivatives.

Dr. Toennies' brilliant success puts in our hands a

compound of inestimable practical and theoretical value, the outcome from which no one can predict.

FREDERICK S. HAMMETT,
Scientific Director
MARINE EXPERIMENTAL STATION OF
THE RESEARCH INSTITUTE OF THE
LANKENAU HOSPITAL,
NORTH TRURO, MASSACHUSETTS

EOCENE LAGOMORPHA

AMONG the discoveries made by the Carnegie Museum field party during the field season of 1932 which are of interest to the paleontologist was that of remains of Lagomorpha in the Upper Eocene of the Uinta Basin in northeastern Utah. This material will add considerably to our knowledge of the phylogeny of this group and will probably have considerable bearing upon Eocene and Oligocene stratigraphy as well.

Actually, the first discovery of Lagomorph fossils in the Uinta Eocene was made in 1923, when a Carnegie Museum field party, consisting of O. A. Peterson and J. LeRoy Kay, found a fragmentary lower jaw in Horizon C at Little Pleasant Valley, about six miles east and south of Myton, Uinta County, Utah. The poor condition of the specimen made it undesirable for a type, and its description was deferred, pending the discovery of better preserved diagnostic material. During the field season of 1931 members of our party obtained a single inferior cheek tooth of a Lagomorph from a horizon in the Duchesne Oligocene series very near the base of the latter beds, about two miles east of Randlett, Uinta County, Utah. In 1932 the Little Pleasant Valley locality near Myton was revisited and a number of excellent specimens, representing at least three species of Leporidae, were found in Horizon C of the Uinta Eocene series, approximately three hundred feet below the base of the Duchesne Oligocene.

This material is being studied by the writer at the present time and will be described shortly in the *Annals* of the Carnegie Museum.

J. J. BURKE
CARNEGIE MUSEUM

BLUE EYES FOR BROWN

FEW nowadays underrate the value of the press in the spread of knowledge. Cheering to certain minds will be in that connection extracts from a correspondence which began when *Collier's Magazine* for July 16, 1932, published in Freling Foster's column "Keeping Up With the World" the statement that:

> After a prolonged absence of sunlight, men on polar expeditions find that their eyes, irrespective of previous color, have turned blue.—*By C. G. Matson, Los Angeles, California.*

Collier's pays $5.00 for contributions such as Mr. Matson's. Under date of July 13 I accordingly tried to sell them the idea that:

> After a prolonged absence of sunlight, men on polar expeditions find that their eyes, irrespective of previous color, are still of the same color.

There came in reply a form letter, saying that my contribution was under consideration. Then, under date of September 7, Freling Foster wrote, declining (by inference) to purchase from me and defending Mr. Matson:

> This contribution was not only accompanied by confirmatory data but it checks with our reference books which describe how the human body is affected by the long polar night.
>
> One book that I can recall offhand is "Sunlight and Health," by Dr. C. P. Saleeby, which was published a short time ago by Putnam.

I checked up the reference and found that on pp. 59–60 of "Sunlight and Health" (N. Y., 1924) Dr. Saleeby says:

> Polar explorers record that, after prolonged absence of sunlight, all the eyes of their men are blue.

Dr. Saleeby did not mention the names of these explorers, and so I wrote him, quoting his own statement and asking further details. On November 24, he replied:

> I wish I could help you, but I know no other reference to the subject than the one which I refer to in my book—taken from the journal of Captain Scott, if I remember aright after all these years.

Here was a clue and I followed it up by writing to Frank Debenham, geologist of Scott's second expedition, now professor of geography in the University of Cambridge and director of the Scott Polar Research Institute. I gave a summary of the correspondence, adding:

> In the book itself I noticed no sign that Dr. Saleeby had relied . . . on the journals of Captain Scott. I am trying to make a rather thorough job of tracing down the belief or fact that eyes change color during the absence of the sun, and surely you at the Institute must have the best command of all the Scott material. I hope, then, that the Institute will be able to give me, first, proof or disproof that comes from the records of any member of the Scott expeditions and, second, any other evidence for or against that may be within your reach.

On December 18, Professor Debenham replied:

> Following up your query about the change of colour of eyes during the polar darkness, a phenomenon which I find it hard to believe, I wrote to our Dr. Levick. . . . I have certainly noticed no such effect.

Surgeon-Commander G. M. Levick, medical officer

and zoologist on Scott's 1910–1913 expedition, replied, December 15, to the institute:

> With regard to my own eyes, I am rather a good example as during our last winter I spent six months with the rest of the northern party. . . . I noticed that my eyes had not changed in colour after this. I think that is the general experience.

VILHJALMUR STEFANSSON

NEW YORK, N. Y.

REPORTS

THE BANTING RESEARCH FOUNDATION

AT its recent annual meeting, the trustees of the Banting Research Foundation reviewed the work accomplished under its grants during the previous year.

The following changes have taken place in the trustees. Sir Robert Falconer has resigned, and in consequence Mr. C. S. Macdonald, president of the Confederation Life Association, was appointed chairman of the board; and Dr. H. J. Cody, president of the University of Toronto, was appointed vice-chairman. Sir William Mulock and Dr. Cody were joined as members of the board, representing the Board of Governors of the University of Toronto, by Dr. H. B. Anderson.

The following workers have received grants from the foundation during the past year: Miss A. M. Alley, McGill University, who has been working under Professor Babkin on gastric and salivary secretion; Dr. Maurice Brodie, McGill University, on poliomyelitis; Dr. H. H. Burnham, University of Toronto, on the vascular supply to the nasal mucosa; Dr. M. M. Cantor, University of Alberta, on the active principle of the adrenal cortex; Dr. H. A. Cates, University of Toronto, representing a committee studying the relation between parentage and the difficulties of childbirth; Dr. A. M. Davidson, University of Manitoba, on the diagnosis of skin diseases and their treatment; Miss Ruth Dow, McGill University, on the auditory area of the brain; Mr. G. T. Evans, McGill University, on the effect of lack of oxygen in exercise, high altitudes and anesthesia on the chemical changes in the heart muscle leading to failure; Dr. R. H. Fraser, University of Manitoba, on the diagnosis of tuberculosis; Dr. J. W. Gilchrist, University of Western Ontario, on the infections following childbirth; Dr. R. Gottlieb, McGill University, on the use of thorium dioxide in the diagnosis of abnormal conditions in the liver; Mr. H. C. Graham, Dalhousie University, on the excretion of uric acid; Miss E. R. Grant, McGill University, on the effect of starvation and exercise on the chemistry of muscle; Mr. J. M. Hershey, University of Toronto, working with Prof. C. H. Best, on the treatment of fatty degeneration of the liver; Mr. F. L. Horsfall, Jr., McGill University, on the fate of lactic acid in the body; Dr. E. E. Shouldice, University of Toronto, on the effect of operations on the intestinal canal; Mr. L. R. LeFave, Queen's University, on the diagnosis of typhoid fever; Professor D. Mainland, University of Manitoba and Dalhousie University, study of the human ovary; Mr. P. G. Mar, University of Manitoba, a study of a rare type of skin disease; Dr. D. R. Mitchell, University of Toronto, on the treatment of urinary infections; Dr. R. A. Moreash, Dalhousie University, on the damage to the liver which is supposed to be produced during the treatment of syphilis; Dr. J. M. McEachren, University of Manitoba, on cholesterol metabolism; Mr. S. Weinstein, University of Saskatchewan, on the oxidation of adrenalin; Dr. A. C. Abbott, University of Manitoba, on the thyroid gland; Professor H. D. Kay, University of Toronto, on experimental ricketts; Professor R. F. Shaner, University of Alberta, on the development of the tracts in the brain of the mammalian embryo; Mr. P. R. Macdonald, McGill University, on the innervation of the lacrymal gland. In addition, a detailed report was received from Dr. F. G. Banting on the work carried out in his department with the aid of funds received from the Banting Research Foundation, which resulted in the publication of eight communications dealing with the pathological changes due to the administration of excessive amount of vitamin D on the intestinal canal during acute intestinal intoxication, and with various methods in analyses required for the work that is being carried on in the department.

V. E. HENDERSON
D. T. FRASER
Honorary Secretaries

SOCIETIES AND MEETINGS

THE TENNESSEE ACADEMY OF SCIENCE

THE Tennessee Academy of Science held its fall annual meeting on November 25 and 26 at Vanderbilt University. In the absence of the president, Dr. A. Richard Bliss, Jr., of Memphis, Dr. Louis J. Bircher, vice-president, presided. Sixty-seven members registered and the average attendance of the public was unusually large.

Two morning and two afternoon sessions were well taken up in the reading and discussion of the thirty

papers on the program, which by reason of the fact that the academy has not organized sections, were all given in the same room and were related to various branches of science—astronomy, physics, chemistry, botany, economics, physiology, genetics, pharmacology and pathology. Seventeen of the papers were by members of the academy teaching or pursuing scientific courses in universities or colleges. The institutions represented were the University of Tennessee, Vanderbilt University, George Peabody College, The Southwestern, Memphis, State Teachers College, Murfreesboro, Tennessee Polytechnic, Cookeville, Carson and Newman College, Jefferson City, Tennessee. Some of the other members contributing papers were R. M. Williamson, director of the U. S. Weather Service, Nashville, "A New Element in Meteorological Observation"; Dr. William Litterer, Tennessee state bacteriologist, "Six Cases of Rocky Mountain Spotted Fever in Tennessee"; Latimer Wilson, of Franklin, Kentucky, "Features of Galactic Structure"; Dr. Lucius P. Brown, formerly food commissioner of New York City, now a farmer of Spring Hill, Tennessee, "Problems of Taxation in Tennessee from the Standpoint of Economics"; John H. DeWitt, Jr., chief engineer of the Radio Station WSM, Nashville, "Vertical Radiators for Broadcasting Stations." Mr. DeWitt in discussing his subject described the steel tower recently erected near Franklin, Tennessee. This is the tallest radiator in the United States, and though 878 feet in height and having a diameter of 38 feet 370 feet above ground, rests on an insulated porcelain plate only about two feet in diameter.

At the Academy dinner, on Friday evening, Professor Bircher, presiding, read a report by President Bliss on "The Reelfoot Lake Biological Station," and Dr. W. G. Harrison, of Birmingham, Alabama, delivered an address on "The History of Medicine." Dr. Harrison discussed especially the contributions of physicians to science in early times and the contribution of scientists to medicine in modern times.

The following officers were elected for 1933: Francis G. Slack, associate professor of physics at Vanderbilt University, *president;* Charles W. Davis, professor of biology at Union University, Jackson, Tennessee, *vice-president;* John T. McGill, professor emeritus of organic chemistry, Vanderbilt University, *secretary-treasurer;* Jesse M. Shaver, professor of biology, George Peabody College, *editor;* Miss Eleanor Eggleston, assistant-librarian, Vanderbilt University, *librarian.*

The meeting of the academy in the spring of 1933 will be held at Walnut Log Lodge, Reelfoot Lake, Tennessee.

JOHN T. MCGILL
Secretary-Treasurer

THE NORTHWEST SCIENTIFIC ASSOCIATION

THE ninth annual meeting of the Northwest Scientific Asocition was held at the Davenport Hotel, Spokane, Washington, on December 28 and 29, 1932. The attendance at the meeting was only slightly lower than that of the previous year, which marked the high point in attendance. In view of the prevailing financial conditions this year's large attendance was highly satisfactory. At the meeting this year, moreover, the out-of-town attendance was noticeably larger.

The presiding officer was Ivan C. Crawford, of the University of Idaho, the president of the organization. At the opening general session on December 28 an address was delivered by Dr. R. R. Parker, of the U. S. Public Health Service, Hamilton, Montana, on the subject "Tick Borne Diseases of the Rocky Mountain Region," and one by Dr. W. F. Thompson, of the University of Washington, Seattle, Washington, on the subject "A Deep Sea Fishery."

In addition to the general sessions, section meetings were held by the following sections: Botany-Zoology, Chemistry-Physics, Education-Psychology, Engineering, Forestry, Geology-Geography, Medicine-Surgery, and Social Science. The program of the Forestry section consisted of a symposium on "Forest Research Needs of the Inland Empire," papers on the progress and needs of research being given on each of the seven phases included, namely, silviculture, fire protection, tree diseases, insects, range management, utilization and economics.

At the business meeting on December 29 important amendments to the constitution were adopted relating to the enlargement of the number of trustees and outlining their duties. This makes possible a machinery for soliciting and caring for bequests, donations, etc., for the prosecution of research in the region. The association also accepted the invitation of the Pacific Division of the American Association for the Advancement of Science to affiliate with that organization.

The officers for 1933 are as follows:

President: Howard R. Flint, U. S. Forest Service, Missoula, Montana.

Vice-president: Thomas Large, Spokane, Washington.

Secretary-Treasurer: Otis W. Freeman, State Normal School, Cheney, Washington.

Councilors: Ivan C. Crawford, University of Idaho, Moscow, Idaho; E. E. Hubert, University of Idaho, Moscow, Idaho; Charles H. Clapp, State University, Missoula, Montana; J. W. Hungate, State Normal School, Cheney, Washington; E. F. Gaines, State College of Washington, Pullman, Washington.

Executive Committee of Trustees: F. G. Miller, Uni-

versity of Idaho, Moscow, Idaho; S. E. Lambert, Spokane, Washington; A. A. Cleveland, State College of Washington, Pullman, Washington.

Additional trustees: L. K. Armstrong, Spokane, Washington; Alfred Atkinson, State College, Bozeman, Montana; C. L. Von Ende, University of Idaho, Moscow, Idaho; R. H. Weidman, U. S. Forest Service, Missoula, Montana; Francis A. Thomson, School of Mines, Butte, Montana; E. O. Holland, State College, Pullman, Washington.

E. E. Hubert, editor of *Northwest Science*, the official publication of the association, was reappointed for the year 1933. Alfred L. Anderson, of the University of Idaho, will continue to serve as assistant editor.

The following were elected as chairmen of the various sections:

Botany-Zoology, A. L. Hafenrichter, State College, Pullman, Washington.

Chemistry-Physics-Mathematics, R. W. Gelbach, State College, Pullman, Washington.

Education, F. T. Hardwick, Whitworth College, Spokane, Washington.

Engineering, G. E. Thornton, State College, Pullman, Washington.

Forestry, F. G. Miller, University of Idaho, Moscow, Idaho.

Geology-Geography, E. T. Hodge, University of Oregon, Corvallis, Oregon.

Medicine-Surgery, R. E. T. Stier, Spokane, Washington.

Social Science, Claudius O. Johnson, State College, Pullman, Washington.

J. W. HUNGATE
Retiring Secretary-Treasurer

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLIFIED METHOD OF STAINING ENDOSPORES

IN our search for simple and efficient stains for routine bacteriological work, the Wirtz[1] method of spore staining proved far superior to others. Hansen's[2] and Möller's[3] techniques make use of steaming carbol fuchsin and an acid decolorizer. Dorner's[4] method, as recommended by the Committee on Bacteriological Technic of the Society of American Bacteriologists, involves the use of nigrosin. Muzzarelli's[5] and Abbott's[6] methods are each good, but even these resort to an acid decolorizer. Wirtz's method proved less complicated than these. Wirtz fixed air-dried smears in osmic acid, stained with malachite green, and used dilute carbol fuchsin as both decolorizer and counterstain. Spores were stained green, cells red. There was no blending of colors such as is often encountered with red and blue dyes.

We have eliminated fixing in osmic acid, shortened the time of staining and substituted aqueous safranin for the dilute carbol fuchsin. The malachite green is made up as a 5 per cent. aqueous solution, allowed to stand one half hour and filtered. This solution seems to be stable. The technique then is: Make films in the usual manner and fix by flaming three times. Flood with malachite green solution and heat to steaming three or four times within one half minute. Wash off the excess stain under the tap for about one half minute. Apply a 0.5 per cent. aqueous safranin solution one half minute. Wash, blot dry and examine. This procedure is evidently more simple than the original method. The whole staining time involved is less than two minutes, and a minimum of steaming is required. Within wide limits it is impossible to overstain or to wash too long.

Application of this method to thirty strains of sporeformers at different ages showed that agar slant cultures incubated at 37° C. for 24 to 36 hours always contain vegetative cells, sporangia and free spores. Thus a complete morphological description can be obtained at this time. Films from week-old cultures, recommended by the Committee on Bacteriological Technique,[7] tend to show excess of free spores and few vegetative cells or sporangia. The search for these structures in such films is time-consuming.

The part of a slant culture from which growth is taken affects the results of the spore stain. Films made from the butt end of a slant show more vegetative cells and fewer sporulated cells than films from the dried upper end of the slant.

The simplicity of the technique and the beautiful differentiation obtained with it should make this method useful for the identification of sporeforming bacteria.

ALICE B. SCHAEFFER
MAC DONALD FULTON

DEPARTMENT OF BIOLOGY
MIDDLEBURY COLLEGE

[1] R. Wirtz, *Zentralblatt für Bakteriologie*, I Abt., Orig., 46: 727, 1908.

[2] Hansen, cited by Buchanan, "Bacteriology," 3d ed., p. 153, 1930.

[3] Möller, cited by Stitt, "Practical Bacteriology, Blood Work, and Animal Parasitology," 8th ed., p. 64, 1927.

[4] W. C. Dorner, cited by Committee on Bacteriological Technic, "Manual of Methods," Leaflet IV, p. 11, 1932.

[5] G. Muzzarelli, *Zentralblatt für Bakteriologie*, I Abt., Ref., 104: 484, 1932.

[6] Abbott, cited by Stitt, "Practical Bacteriology, Blood Work, and Animal Parasitology," 8th ed., p. 64, 1927.

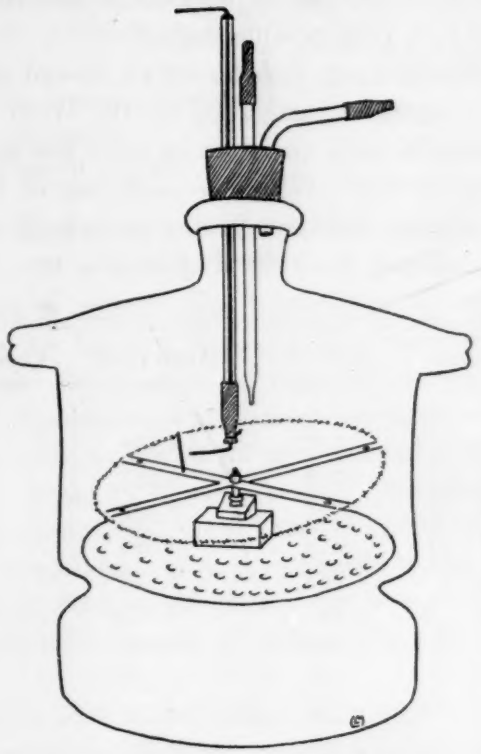
[7] Committee on Bacteriological Technic, "Manual of Methods," Leaflet V, p. 5, 1930.

A DEMONSTRATION JAR FOR WHITE MICE

A MOUSE in a closed vessel of known capacity is a favored way of showing roughly some of the effects of inhalation anesthetics. Motor excitement and depression may be noted, but not well, for in the limited space the mouse has nowhere to run. For this reason we have mounted a simple tread-mill in a 5 liter desiccator, so arranged that the number of revolutions is recorded on a slow kymograph. The apparatus is easily constructed without expense and permits a number of interesting experiments and demonstrations.

The wheel is a circle of screen wire just smaller than the inner diameter of the desiccator, thumb-tacked to two light pieces of wood at right angles to each other. Its bearing is a piece of glass tubing about 2 cm long pushed through a tight hole where the sticks cross. The ends of the tubing are fused down until they fit freely, but without unnecessary play, a small finishing nail. With a washer below this makes a very freely turning wheel, and when mounted on a block at about 30° to the horizontal the mouse has no trouble and apparently a good deal of pleasure in running it.

The recording device is very simple. A piece of glass tubing about 18 cm long is put through a hole in a rubber stopper in the top of the desiccator. The ends of this tube are fused down to fit loosely a piece of iron wire. A short piece of rubber tubing is fitted over the lower end of the glass tube and tied securely around the wire. This makes a gas-tight joint, and also serves as a spring to resist rotation of the wire. Each end of the wire is bent at right angles. The lower bend is hit by a pin on the revolving wheel, the upper end is connected by a thread to a damped-down muscle lever. Thus every revolution of the mouse wheel, in either direction, is made to record on



the kymograph, which of course also carries a suitable time tracing. Two other glass tubes through the rubber stopper allow gas or volatile liquids to be run in. An electrical contact is avoided in the recording mechanism because of the explosibility of several of the anesthetic mixtures.

C. REYNOLDS

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SPECIAL ARTICLES

VARIABILITY AND INDIVIDUALITY

IN 1920 the writer[1] published data which demonstrated that young animals of an inbred strain of mice showed a significantly higher percentage of growth of an inoculated tumor than did sexually mature individuals of the same strain. Strong[2] confirmed these results with different material and showed in addition that senile animals resembled very young animals in that they exhibited an increased tolerance of tumor implants as compared with that of young adults. These data were interpreted as indicating that the full expression of the genetic constitution of the individual was being assumed gradually during the period of infancy and adolescence, reached its most characteristic manifestation at the young adult stage and became less integrated and more decentralized during senility.

Warthin,[3] Child[4] and others have considered senility as a period of *involution,* and have looked upon individuality as a process directly measurable by the degree of manifestation of certain functions.

From evidence derived from a considerable mass of material it would appear that variability of a function or characteristic is a more fundamental indication of the nature of individuality than is the mean value of any physiological or morphological characteristic at any given time.

When, for example, variables of a genetic nature are reduced to a minimum for mammalian material by the use of closely inbred strains and when the

[1] *Jour. Exper. Zool.,* 31: 307–326, 1920.
[2] *Jour. Exper. Zool.,* 36: 67–134, 1922.
[3] "Old Age The Major Involution," Hoeber, N. Y., 1929.
[4] "Senescence and Rejuvenescence," Univ. of Chicago Press, 1915.

ontogenetic variables are to some extent controlled by the use of one sex and by the choice of some physiological function confined to a restricted period of the life cycle, the experimental conditions are simplified to a considerable degree.

Data derived from females of an inbred strain of mice (dbr) under investigation by Dr. W. S. Murray are available to show variation in litter size at various ages of the mother. When the coefficient of variation of litter size at successive 30-day periods of maternal age is calculated the following results are obtained.

Age of mother in days	No. of litters	Mean litter size	Coefficient of variation
– 75	517	4.189	42.46
76–105	1298	4.985	38.81
106–135	1026	5.436	36.94
136–165	978	5.598	36.96
166–195	762	5.767	35.43
196–225	691	5.363	40.25
226–255	598	5.055	40.60
256–285	433	5.173	41.52
286–315	286	5.108	43.45
316–345	194	4.613	51.94
346–375	105	4.314	47.46
376–405	49	4.469	41.70
406–	34	3.470	58.56

It will be noted that variation in litter size begins high, decreases, reaches a base level and then increases again as reproductive activity decreases and senility sets in.

A very similar result with, however, a shorter constant base level period was obtained for another inbred strain of mice (C 57). The slight difference between the two strains is probably a natural concomitant of the genetic characteristics which they each possess.

Looked at from the point of view of variation in physiological response to a constant stimulus, the work of the writer and of Strong on inoculated tumors already referred to, agrees in general with the data on litter size. In so far as somatic tissues are concerned there is good reason to believe that the age-variability relationship above described may be of general applicability.

The next question is whether a similar relative change in variability incidental to age applies also to the functioning of the germ cell. On *a priori* grounds there is no reason why the germ cell, as an organization, should not also show a durational phase in its various activities.

Data presented by Bridges[5] bear on this point. Using "crossing-over" between genes as an index and *Drosophila* as material he studied the relation of age to the absolute amount of crossing-over. He did not, however, analyze his data from the point of view of *variability* of the function of crossing-over in relation to the age of the mother. When his data for single cross-overs are studied with this point in mind certain suggestive and interesting results are obtained.

The average variability in his two main tables shows the following distribution according to the age of the mother.

Age period of mother from youngest to oldest	Percentage of variability in single "crossing-over"
1	39.52
2	30.17
3	18.83
4	22.82
5	24.00
6	21.96
7	14.63
8	12.56
9	4.87
10	15.27
11	26.53
12	34.82

Again the very young and the very old females show the most variation. There is a secondary decrease in the third period but the primary stability seems to be in the ninth. While the evidence is not conclusive it supports the idea that very young and very old germ cells function more variably than do those of the middle-age periods.

This is an important conclusion and if substantiated by further data on different materials will lead us far towards a better understanding of various general evolutionary problems of prime importance.

(1) It might well develop that tendency to mutation, which in itself is an indication of variability, would be greater in very young and in very old germ cells.

(2) If this were true, domestication, in which very young and very old animals, protected from the competitive factor of natural selection, are used as parents, would provide a far greater chance for mutations to occur than would natural conditions.

(3) Similarly, somatic mutations would tend to be more frequent in very young or very old animals. Evidence that this is the case is to be found in the work of Strong,[6] Bittner[7, 8] and Cloudman,[9] who found genetic differences in spontaneous mammary

[5] Carnegie Inst. of Wash., Publ. No. 399, 1929.

[6] *Jour. Cancer Research*, 13: 103–115, 1926.
[7] *Am. Jour. Cancer*, 15: 2202–2247, 1931.
[8] *Am. Jour. Cancer*, in press.
[9] *Am. Jour. Cancer*, 16: 568–630, 1932.

neoplasms produced by a single individual mouse. These various animals had very evidently reached a point where central physiological control of the variability of somatic cell variation had diminished to a stage where they no longer acted as individuals in the restricted sense.

(4) The origin of neoplasms as the result of the fundamental disintegration of a centrally controlled "individuality" would become more clearly established. Different types of neoplasms would naturally be expected to follow different age distributions—as they do—because the different tissues are organ systems of the body "age" physiologically at very different periods in ontogeny. As matters stand there seems to be sufficient evidence to conclude:

(1) "Individuality" in mammals and probably in all higher animals is a relative term with a well-pronounced durational phase.

(2) Within genetically comparable material, variability in form and function is greater in the very young and in the very old than it is in the height of reproductive efficiency.

(3) Measurements of simple increase or decrease in function are not sufficient to give a complete picture of the nature of individuality.

(4) Senility is not simply a "major involution" but rather a period at which the disintegration of individuality is the most interesting biological phenomenon. "Involution" as a concept suggests the opposite of "evolution." It would be much more accurate to consider old age as a period primarily of a type of physiological and morphological disintegration and incoordination.

(5) All studies of genetic characters in animals should consider the age factor as an important variable likely to influence fundamentally the justifiable conclusions as to the type and nature of the character under consideration.

(6) This applies not only to genetic characters and processes outside of the germ-plasm but to such characters and processes as mutation, crossing-over, and other chromosomal aberrations. It may be expected that variability in relation to age will be operative in all germ cells to a more nearly comparable degree than it will be in the somatic characters of various groups of organisms.

(7) There is, however, little likelihood of general mathematical values for such variation being immediately established since the genetic characters of strains and individuals would be expected to vary in so far as they affect the assumption and degeneration of "individuality."

(8) The existence of the durational phase in the development of individuality helps to bridge the gap which has existed between physiologic and theoretic genetics. It shows that geneticists must recognize and consider that factor before the gene-character relationship can become sufficiently definite to allow accurate evaluation of gene location, dominance and other genetic phenomena.

C. C. LITTLE

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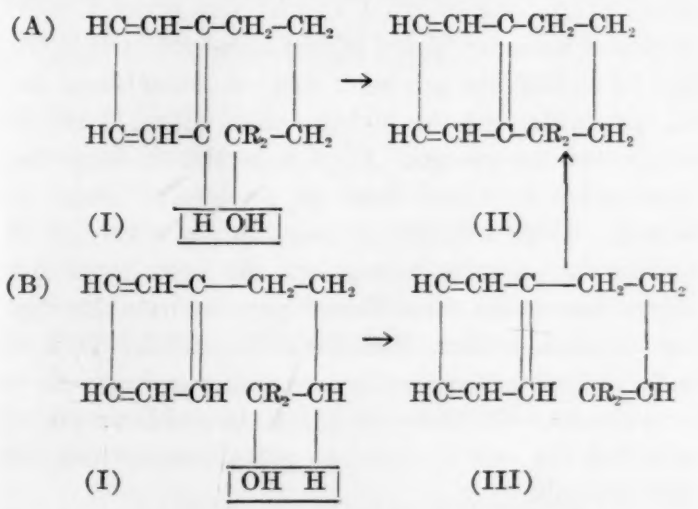
BAR HARBOR, MAINE

THE MECHANISM OF THE IONENE SYNTHESIS

IN a recent report[1] we described a synthesis of ionene that for the first time provides convincing evidence of the constitution of this interesting hydrocarbon, which has so lately risen to prominence in connection with studies of the structure of vitamin A.

Further work by Davidson and Apfelbaum, in these laboratories, has now thrown additional light upon the mechanism of this synthesis, in so far as the transition from a monocyclic tertiary alcohol (I) to a dicyclic hydrocarbon of ionene type (II) is concerned.

Manifestly, such a cyclization involves the elimination of a molecule of water, and this may be accomplished by the OH of the tertiary alcohol removing an H, either from the benzene nucleus, thus forming the second cycle, as shown in (A); or (B), from the adjacent CH_2 group, with production of the olefin (III), which then isomerizes to the dicyclic hydrocarbon (II), a type of rearrangement not at all uncommon in terpene chemistry:



Since the next lower homolog (I) is much more easily prepared than the tertiary alcohol used for the synthesis of ionene itself, this was used in our experiments, as shown in the formulas above, and gave the corresponding lower homolog (II) of ionene.

That (B), rather than (A), represents what actually occurs in this cyclization is indicated by the following experimental facts:

[1] M. T. Bogert, SCIENCE, n.s., 76: 1977, 475, November 18, 1932.

(1) If heated with iodine as a catalyst, the tertiary alcohol (I) readily yielded the olefin (III).

(2) This olefin rearranged immediately to the dicyclic hydrocarbon (II) when digested with concentrated sulfuric acid.

(3) Treated with the proper concentration of sulfuric acid, or phosphoric acid, the alcohol (I) passed immediately to the olefin (III), which on longer treatment changed to the ionene homolog (II). Hence, either (III) or (II) was obtained, depending upon the duration of the treatment.

These reactions are now being extended and applied in manifold directions, for the synthesis of numerous polycyclic hydrocarbons and of derivatives not readily accessible by other methods.

MARSTON TAYLOR BOGERT
LABORATORIES OF ORGANIC CHEMISTRY
COLUMBIA UNIVERSITY

THE VITAMIN D POTENCY OF EGG YOLK FROM IRRADIATED HENS

IN five experiments, tests were made to determine the relative antirachitic potency of egg yolk from irradiated hens. Four flocks of hens were used. (1) An irradiated flock of 350 hens had the usual laying ration containing one half per cent. cod-liver oil plus four hours daily access to the ultra-violet rays from one GE Model S-1 Sunlamp; (2) a non-irradiated flock of like size fed the same ration. (Both of these flocks averaged 62 per cent. production during the continuance of the experiment—five months). (3) A small farm flock (Exp. 1 and 2) was given a poorly balanced ration. These birds were producing from ten to twenty-five per cent. (4) Another farm flock of 150 birds, fed the laying ration (Exp. 4 and 5), completed the groups. Eggs were chosen from these hens after they had been in production about one month. They were laying about 50 per cent. daily.

The antirachitic potency of the eggs from these flocks was tested on different pens of rats, having a rachitogenic ration, Steinbock No. 2965. Different amounts of the egg yolk were fed, varying with the experiment. In three of the tests cod-liver oil was also fed the rats in order to make comparisons with the egg yolk.

The experiments confirmed the work of earlier investigators, showing that egg yolk contains appreciable amounts of vitamin D. The tests give clear evidence that irradiation of hens with ultra-violet rays will markedly increase this vitamin above the quantity normally found in eggs. A high vitamin D content may thus be maintained throughout the winter months.

[1] Aided by a grant from the Heckscher Research Foundation.

In the experiments where the quantity of egg yolk was 5 per cent. or more, that from irradiated hens prevented or cured rickets in rats almost as rapidly as exposure to a quartz mercury arc. Ten per cent. of such egg yolk in the rachitogenic diet was as effective as one half per cent. cod-liver oil, or radiations from the quartz mercury arc. These animals grew faster than the irradiated rats because in addition to the antirachitic factor the egg yolk supplied other necessary food ingredients.

Four per cent. egg yolk from the irradiated hens was more potent than one eighth per cent. of cod-liver oil in the rat diet.

While the non-irradiated hens had access to autumn sunshine (during November, 1931, the weather remained unusually fair in New York) the vitamin D content was sufficient to cure rickets. In this high-producing flock, as winter advanced and the hens had been in production longer and longer, the vitamin D content diminished to a low level, much below the amount necessary for satisfactory prevention or cure of rickets.

There seemed also to be a limited ability for hens to store vitamin D and to transfer it to the eggs when needed.

From the tests with farm flocks it was shown that eggs as ordinarily purchased contain varying amounts of vitamin D. Under the most favorable conditions the quantity may be quite adequate to prevent rickets in experimental animals. The season and the volume of production are at least two of the factors which determine the amounts.

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